REPORTING LED LUMINAIRE PRODUCT PERFORMANCE

An Initiative for Better Solid State Lighting

Next Generation Lighting Industry Alliance
with the
U. S. Department of Energy

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A joint committee of the U.S. Department of Energy (DOE) and the Next Generation Lighting Industry Alliance (NGLIA) has undertaken an effort to assure and improve the quality of solid state lighting (SSL) products. This brochure on LED Luminaire Performance reporting is the initial outcome of that effort. The ultimate goal is to develop an expanded community of *SSL Quality Advocates* throughout the supply chain who are committed to support and implement continuous improvement of SSL product quality.

The rapid growth of SSL has resulted in an increasing number of new products on the market for various lighting applications. While some of these are excellent introductions and showcase the energy-savings potential for SSL, quite a few under-performing products are also appearing in the market. Such products can discourage the early adopters of this new technology, significantly delay market penetration, and may thus disadvantage the entire industry. This situation also occurred in the early days of compact fluorescent lighting, inhibiting market acceptance of CFL products and negating significant potential energy savings in subsequent years.

To avoid, or at least reduce, this problem in emerging markets for solid state lighting, DOE urges manufacturers to agree, as a foundation of product quality, on accurate and consistent ways to report product performance, whether it is in product labeling, product packaging, product literature, press releases, or manufacturer data sheets.

DOE and NGLIA recommend that a minimum set of critical parameters, described below, be reported by luminaire manufacturers to accurately reflect the performance of their products. While not formal standards or requirements at this time, ideally these recommendations would be uniformly adopted for LED lighting product sold in the United States. These recommendations currently apply only to LED

lighting, and this document refers only to self-contained replacement lamps, light engines, and full luminaire products, not packaged LED devices.[1] Luminaire recommendations are intended to better inform designers, contractors, and other professionals about the performance they can expect from a lighting product and its suitability for the intended application. Some subset of these critical parameters, in a simplified form, may also be suitable for the retail market.

The initial five recommended parameters for performance reporting are:

- Luminaire efficacy
- Light output of the luminaire
- Measured input power
- Correlated color temperature
- Color rendering index

To provide lighting purchasers more product information, other metrics may be considered in the future, such as those related to reliability, product consistency, or construction. While standardization may make these recommendations obsolete, it is often sufficient simply to ensure that results are completely and consistently reported and accompanied by adequate background information to allow buyers to make a fair comparison among the products available for purchase.

[1] For definitions of the various SSL product levels, please refer to ANSI/IESNA RP-16-05 Addendum a, "Nomenclature and Definitions for Illuminating Engineering," May 2008.

LUMINAIRE PERFORMANCE METRICS

Reported *component-level* measurements are, with a few exceptions, adiabatic or nearly so; that is, they are taken over a short interval so as not to appreciably change the temperature of the LED chip during the measurement. As a result, component-level performance figures are generally optimistic and may differ significantly different from those that would be obtained under normal operating conditions.

Manufacturers of luminaires should insist on good component specifications, including thermal performance and lifetime characteristics, from their suppliers, but should also be aware that this information is not sufficient to describe the finished product. One of the most common misrepresentations of luminaire product performance is simply reporting the device performance without accounting for the influence of driver and luminaire design.

The following recommended parameters apply to all embodiments of LED products that include a driver—the "Lamp" and "Luminaire"—but manufacturers must use care in comparing lamp measurements to full luminaire results. Luminaire measurements, unlike component-level measurements, have generally been standardized with the issuing of IESNA Standard LM-79-2008. It is important to note that this standard specifies *absolute* photometry.

Luminaire Efficacy *(Lumens per Watt) is a specific measure of the net useful light output from the luminaire for a given power input.* Properly measured, Luminaire Efficacy combines both the light source system efficacy and luminaire efficiency, allowing for a true comparison of a luminaire regardless of the light source. Luminaire efficacy is the preferred metric for LEDs because it measures the net light output from the luminaire divided by power into the system, accounting for driver, optical, and thermal losses. Methods for

measuring luminaire efficacy of solid state lighting fixtures and lamps are defined in the IESNA standard, LM-79-2008.

Reported efficacy values for a given product can vary greatly depending on how light output and power use measurements are taken. For example, light output could be measured from a light source alone, from an entire luminaire, or within a specific test area. Input power could be specified alternatively as into the light source alone, into a ballast plus source, into a power supply with driver electronics, or at the 120 VAC wall plug. The energy-efficiency community has traditionally compared light sources based on system efficacy, rated lamp lumens divided by power into the system that includes source and driver. This doesn't work for LEDs because there are no standard LED lamp packages or lamp ratings, and, perhaps most importantly, because LED performance depends on the thermal, electrical, and optical design of the system or luminaire.

Light Output of Luminaire *is the total lumens output by a luminaire (as a whole).* For SSL products, luminaire light output must be determined by measuring the output of the entire luminaire (including the LED device, thermal management, fixture, and optics) in an integrating sphere or goniophotometer using absolute photometry.

Measured Power *is the total power consumed by a luminaire measured in Watts*. In all cases, the luminaire power should be measured upstream of power supply/driver. For example, for a luminaire that includes a wall plug, the measured power is at the wall socket input. For a luminaire wired directly to 120 VAC, the measured power is at the 120 VAC input.

Correlated Color Temperature (CCT) *for an SSL luminaire ideally should be determined through integrating sphere testing of the whole luminaire.* If this test result is not available, the CCT value for the LED device used in the luminaire can be reported, but reports must

indicate that the CCT value was measured at the LED device level. The CCT of the luminaire may differ from the CCT of the device for any of several reasons:

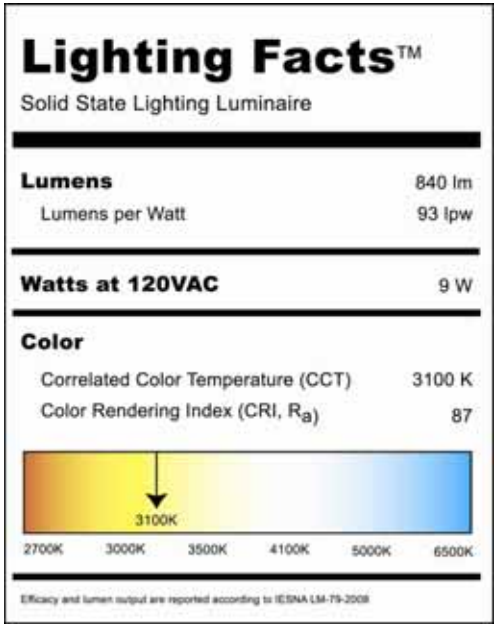
- Operating currents and temperatures can affect the color temperature of an LED device.
- Reflective surfaces or a translucent enclosure on the fixture can change the CCT.
- An array of LED sources may include multiple devices with different CCT values.

Ideally, both Color Coordinates in the CIE 1931 *x,y* Chromaticity diagram and Correlated Color Temperature (CCT in degrees Kelvin) should be reported using ANSI C-78-377-2008, Specifications for the Chromaticity of Solid-State Lighting Products, because there can be confusion about what CCT means, especially if the coordinates are well off the Planckian locus.

Color Rendering Index *(CRI) should be measured according to the standard R_a method used for conventional sources.* As with other measurements, the CRI should be measured for the luminaire in normal steady-state operation to account for any effects of temperature or luminaire design on color.

AN INVITATION TO JOIN *SSL QUALITY ADVOCATES*

This brochure is the first step in an ongoing effort to enhance the quality of SSL products. The DOE is developing a pledge program to expand the community of *SSL Quality Advocates* committed to quality improvement. Luminaire manufacturers who join agree to add a simple *Lighting Facts*™ label to the product, packaging, or accompanying literature specifying the minimum parameters. Similar reporting recommendations will soon be available for source manufacturers. Other *SSL Quality Advocates*, including those who purchase or specify, agree to ask that their suppliers adhere to these recommendations. More information on the SSL Quality Pledge program will be available soon on the DOE *SSL Quality Advocates* website at www.lighting-facts.com.



The Lighting Facts™ *label provides a quick and simple summary of the critical parameters for a luminaire described in this brochure.*